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Into Thin Air: Mountain Climbing Kills Brain Cells
The neural cost of high-altitude mountaineering

By R. Douglas Fields

Three attributes of a good mountaineer are high pain threshold, bad memory, and ... I forget the third. —Joke in a mountaineering Internet chat room

In the late 1890s in a laboratory atop a 4,554-meter peak in the Monta Rosa range in the Italian Alps, physiologist Angelo Mosso made the first direct observations of the effects of high altitude on the human brain: by eye and with an apparatus he designed, Mosso peeked into the skull of a man whose brain had been partly exposed in an accident, observing changes in swelling and pulsation.

Now a similar experiment has been done with noninvasive brain imaging, and for those of us who love to climb the results are not elevating. Neurologist Nicolás Fayed and his colleagues in Zaragoza, Spain, performed MRI brain scans on 35 climbers (12 professionals and 23 amateurs) who had returned from high-altitude expeditions, including 13 who had attempted Everest. They found brain damage in virtually every Everest climber but also in many climbers of lesser peaks who returned unaware that they had injured their brain. It seems that climbers of high mountains, whether weekend warrior or seasoned professional, face returning from the high peaks with a brain that is not in the same condition it was in beforehand.

What Gives in a Climber's Brain?
Although a person’s tolerance to hypoxia (lack of oxygen) varies according to differences in innate physiology and physical conditioning, no one is immune. Those effects can be acute, affecting you only while you are at altitude, or—as the Fayed study found—they can be longer-lasting.

The first acute stage is called, naturally enough, acute mountain sickness. It can cause headache, insomnia, dizziness, fatigue, nausea and vomiting. The next, more serious stage is high-altitude cerebral edema, also known as HACE, brain swelling that is potentially fatal.

Lack of oxygen can directly damage brain cells. In addition, the walls of blood capillaries begin to leak at high altitudes, and the leaked fluid can cause dangerous swelling, pressing the brain outward against the rigid skull. Sometimes the optic nerves swell so badly they bulge into the back of the eye, degrading vision and causing retinal hemorrhages. Meanwhile blood, concentrated from dehydration and thickened by increased numbers of red blood cells, clots more easily. This clotting, along with the hemorrhage from the thinned capillaries, can cause a stroke. A climber with HACE may experience amnesia, confusion, delusions, emotional disturbance, personality changes and loss of consciousness.

Severe cases of acute high-altitude disease have long been known to cause brain damage. But one of the sobering things about the Fayed study is that even when climbers showed no signs of acute sickness, the scans still found brain damage.

The results in the Everest climbers were the starkest. Of the 13 climbers, three had made the 8,848-meter summit, three had reached 8,100 meters, and seven had topped out between 6,500 and 7,500 meters. The expedition had no
major mishaps, and none of the 12 professional climbers evinced any obvious signs of high-altitude illness; the only acute case of mountain sickness was a mild one in the expedition’s amateur climber. Yet only one of the 13 climbers (a professional) returned with a normal brain scan. All the scans of the other 12 showed cortical atrophy or enlargement of the Virchow-Robin (VR) spaces. These spaces surround the blood vessels that drain brain fluid and communicate with the lymph system; widening of these VR spaces is seen in the elderly but rarely in the young. The amateur climber’s brain had also suffered subcortical lesions in the frontal lobes.

How High Is Too High?

Of course, Everest is extreme. Fayad and his colleagues also studied an eight-person team that attempted Aconcagua, a 6,962-meter summit in the Argentine Andes. Two climbers reached the summit, five climbed to between 6,000 and 6,400 meters, and one reached 5,500 meters. Yet three members experienced acute mountain sickness, and two displayed symptoms of brain edema—probably because they ascended more rapidly from lower altitudes than the Everest climbers did.

All eight Aconcagua climbers showed cortical atrophy on MRI scans. Seven showed enlarged VR spaces, and four showed numerous subcortical lesions. Some needed no scan to tell them their brains had been injured. One climber suffered aphasia (problems with speech), from which he recovered six months later. Two complained of transient memory loss after returning, and three others struggled with bradypsychia (slowed mental function).

The body is remarkably resilient: Does the brain recover from these mountaineering wounds? To answer this question, the researchers reexamined the same climbers three years after the expedition, with no other high-altitude climbing intervening. In all cases, the damage was still apparent on the second set of scans.

Still, Aconcagua is one of the world’s highest mountains. Mont Blanc in the western Alps is less extreme. Its 4,810-meter summit is climbed every year by thousands of mountaineers who probably do not expect injury to their “second favorite organ,” to use Woody Allen’s nomenclature for the brain. Yet the researchers found that of seven climbers who reached Mont Blanc’s summit, two returned with enlarged VR spaces.

Because Why?
The study suggests that chronic exposure to high altitudes is not required to experience irreversible brain damage. In fact, amateurs seem to be at greater risk, because they are more likely to suffer acute mountain sickness or high-altitude cerebral edema. At the same time, the experience required to become well acclimated seems to take an ever increasing cumulative toll; compared with the amateurs, professional climbers in this study had greater cortical atrophy overall. They felt stronger but showed more brain damage.

Mountain climbing is growing in popularity—and with good reason. It can provide experiences of a lifetime; a communion with nature and with friends that feeds the soul; intense and enduring rewards surpassing those found within the bounds of routine; and adventure and challenge that build courage, stamina and fortitude. It also gets you into incomparable mountain wilderness—although that is vanishing. Many sense that the singular “it” residing in George Mallory’s pithy raison d’ascent—“Because it’s there!”—may soon be gone.

Some 5,000 climbers ascend Himalayan peaks every year. Thousands more climb peaks in the Alps and Andes. Many of these people spend liberally to mount expeditions or to be guided to the summit. But it is increasingly clear that these climbers are paying for the privilege with something more than hard-earned cash. They’re paying with brain tissue.

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